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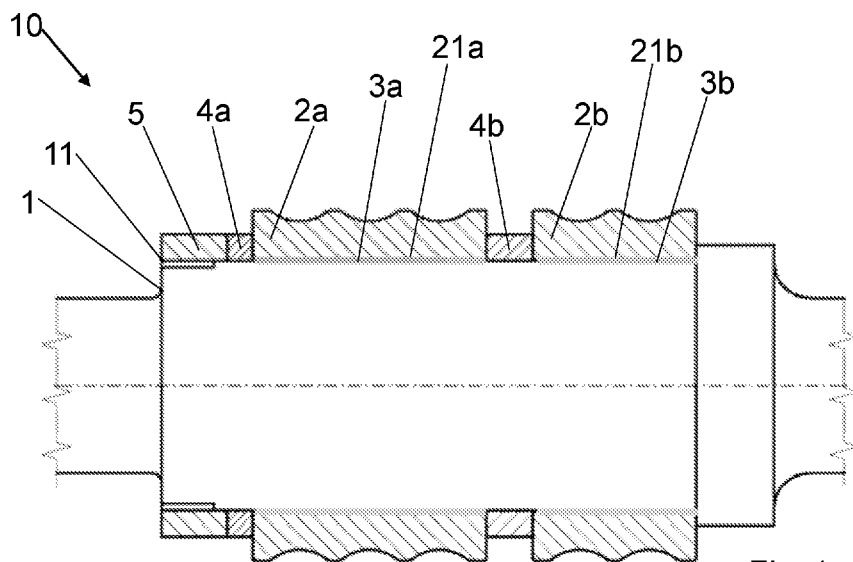


Fig. 1

(57) Abstract: A rolling roll (10), in particular for long products, comprising a shaft (1) and one or more rolling rings (2a, 2b) mounted on the shaft (1), wherein the shaft (1) and the one or more rolling rings (2a, 2b) are coupled to one another with interference, in particular without mechanical clearances between the shaft (1) and the one or more rolling rings (2a, 2b), and wherein the internal surface (21 a, 21 b) of the one or more rolling rings (2a, 2b) is glued to a surface (11) of the shaft (1); and a method for dismounting the one or more rolling rings (2a, 2b) of the shaft (1) of this rolling roll (10), in which the steps of: a) cooling the shaft (1) by means of a cryogenic fluid, preferably liquid nitrogen, in particular so as to reduce the diameter of the shaft (1); b) removing the one or more rolling rings from the shaft (2a, 2b) are provided.

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ROLLING ROLL AND RELATED DISMOUNTING METHOD

Field of the invention

The present invention relates to the field of rolling of metallurgical products.

- 5 In particular, the invention relates to a rolling roll comprising, in particular during use, a shaft and one or more rolling rings mounted on the shaft itself.

Background art

The rolling rolls for rolling semi-finished products and metallurgical products comprise one or more rolling rings mounted on a shaft.

- 10 Some rolling rolls comprise a ring holder mounted on the shaft, and the rolling ring is mounted on the ring holder. The ring is fastened to the ring holder by locking elements such as keys, tabs and other components.

- Other rolling rolls on the other hand involve direct coupling, by geometric interference, between the rings and the shaft. For example, for mounting and
15 dismounting, each rolling ring is heated so that the rolling ring dilates, increasing its internal diameter so as to be able to be inserted in position on the shaft; the rolling ring is then left to cool so that it returns to its original size, thus determining the coupling. This coupling method imposes limits on the material of which the rolling rings are made. Indeed, the rings made of material with a lower thermal expansion
20 coefficient with respect to that of the material of which the shaft is made cannot be dismounted with this method. Furthermore, rings made of some materials do not withstand the thermal shock that occurs when the ring is heated and cooled.

Therefore, the need is felt to overcome the limits of the prior art.

Summary of the invention

- 25 An object of the present invention is to improve the coupling method between one or more rolling rings and the shaft of a rolling roll.

An object of the present invention is to improve the dismounting method of the one or more rolling rings from the shaft of a rolling roll.

- The present invention achieves at least one of these objects, and other objects
30 that shall become clear in light of the present description, with a rolling roll, in particular for long products, according to claim 1, which comprises a shaft and one or more rolling rings mounted on the shaft; wherein the shaft is coupled with

interference to the one or more rolling rings, in particular without mechanical clearances between the shaft and the one or more rolling rings; and wherein the internal surface of the one or more rolling rings is glued to a surface of the shaft.

In particular, said surface of the shaft has a larger diameter than the diameter of said internal surface of each of the one or more rolling rings, in particular when the shaft and the one or more rolling rings are at room temperature and in particular during use. In other words, the outer diameter of the portion(s) where the one or more rolling rings is/are mounted is greater in diameter than the through hole of the one or more rolling rings.

“Room temperature” means in particular a temperature equal to about 20 or 25 °C.

The invention also relates to a method, according to claim 14, for dismounting the one or more rolling rings from the shaft of a rolling roll, wherein the following steps are involved:

- a) cooling the shaft by a cryogenic fluid, preferably liquid nitrogen, in particular so as to reduce the diameter of the shaft; in particular so as to break the layer of glue between the shaft and the one or more rolling rings;
- b) removing the one or more rolling rings from the shaft.

Advantageously, a roller according to the invention requires a smaller number of components, in particular it does not require a ring holder; it can be made by simpler mechanical processes, in particular it does not require rings with conical holes nor seats for keys; and it furthermore offers the possibility of having a greater work width of the ring.

Advantageously, the shaft and the one or more rolling rings are coupled together both by interference, in particular geometric interference i.e. mechanical interference, and by gluing.

Coupling by interference allows better gluing between the shaft and the one or more rolling rings. In particular, there is a better distribution of the glue on the surface to be glued. Further, in particular in the case wherein anaerobic glue is used, polymerization of the glue is promoted.

Advantageously, the method according to the invention allows the use of rolling rings made of materials, such as for example a metallic carbide, having a lower

coefficient of thermal expansion with respect to the coefficient of thermal expansion of the shaft which is, in particular, made of steel.

In particular, the method also allows rolling rings made of materials having a lower coefficient of thermal expansion with respect to steel to be dismounted, for which
5 the heating of the assembly would not be useful for dismounting.

The invention further relates to a rolling apparatus or system according to claim 17.

Further features and advantages of the invention will become more apparent in light of the detailed description of exemplary but not exclusive embodiments.

10 The dependent claims describe particular embodiments of the invention.

Brief description of the figures

In the description of the invention, reference is made to the accompanying Figure (Fig. 1), provided by way of non-limiting example, illustrating a sectional view of a rolling roll according to the invention.

15 Description of illustrative embodiments of the invention

With reference to the Figure, non-limiting examples are described of a rolling roll 10 and a related method for dismounting one or more rolling rings 2a, 2b from the shaft 1 of the rolling roll 10.

The rolling roll 10 is used in particular for rolling a metal product, in particular a
20 long metal product, such as billets, bars, wire rods, rods or other similar products known in the steel sector.

However, a rolling roll according to the invention may also be a roll for rolling flat products, such as slabs and strips.

The rolling roll 10, in particular when it is assembled for being put in use,
25 comprises a shaft 1 and one or more rolling rings 2a, 2b mounted on the shaft 1. Advantageously, the shaft 1 and the one or more rolling rings 2a, 2b are coupled together with interference (i.e. by interference), in particular without mechanical clearances between the shaft 1 and the one or more rolling rings 2a, 2b; and the internal surface 21a, 21b of the one or more rolling rings 2a, 2b is coupled by gluing,
30 i.e. it is glued, to a surface 11 of the shaft 1, said surface 11 of the shaft being in particular an outer surface of the shaft.

In other words, the internal surface 21a, 21b of the one or more rolling rings 2a, 2b and said surface 11 of the shaft 1 are glued together by a layer of adhesive material 3a, 3b, in particular a glue, preferably an anaerobic glue. The Figure diagrammatically illustrates the respective layers of adhesive material 3a, 3b with which each rolling ring 2a, 2b is glued to the respective surface portion 11 of the shaft 1.

In particular, the one or more rolling rings 2a, 2b are glued directly to said surface of the shaft 11, more in particular without any bodies or intermediate elements interposed between the shaft 1 and the one or more rolling rings 2a, 2b.

10 Preferably, the adhesive material 3a, 3b with which the rolling rings 2a, 2b are glued to the shaft 1 is an anaerobic glue, which has the particular feature of polymerize in the absence of oxygen. Preferably, the glue 3a, 3b is of the single-component type. Preferably, the glue is methacrylic urethane (urethane methacrylate).

15 Advantageously, the shaft 1 and the rolling rings 2a, 2b are configured so that there is interference, i.e. geometric interference (or diametrical interference or mechanical interference) between them, in particular when these components are at room temperature, and under normal operating conditions, i.e. during rolling.

In particular, said surface 11 of the shaft 1 has a diameter, in particular a maximum diameter, which is greater than the diameter, in particular with respect to the maximum diameter, of said internal surface 21a, 21b of each of the one or more rolling rings 2a, 2b.

20 Preferably, the geometric interference between each rolling ring 2a, 2b and the shaft 1 is in the range from 0 to 1 ‰ (per mil), in particular from 0.1‰ to 1‰; preferably in the range from 0 to 0.2 ‰ (per mil), in particular from 0.1‰ to 0.2‰. In particular, the diameter of the surface 11 of the shaft 1 is greater from 0 to 1 ‰ (per mil), in particular from 0.1‰ to 1‰, or from 0 to 0.2 ‰ (per mil), in particular from 0.1‰ to 0.2‰, with respect to the diameter of the hole of each rolling ring 2a, 2b or in other words with respect to the diameter of the internal surface 21a, 21b of each rolling ring 2a, 2b. In the case where the surface 21a, 21b of each rolling ring 2a, 2b is conical, reference is made to the maximum diameter of the surface 21a, 21b.

The rolling rings 2a, 2b may be adapted, for example, to perform the roughing, or finishing or rolling in general, both of ferrous and non-ferrous products.

The shaft 1 preferably has a coefficient of thermal expansion or coefficient of thermal dilation greater than the coefficient of thermal expansion of the one or more rolling rings 2a, 2b. In other words, the shaft 1 is made of a first material having a first coefficient of thermal expansion, and the one or more rolling rings 2a, 2b are made of a second material, different from the first material, having a second coefficient of thermal expansion which is lower than the first coefficient of thermal expansion.

Preferably, the shaft 1 is made of steel.

Preferably, the one or more rolling rings 2a, 2b are made of carbide, preferably metallic carbide.

Preferably, the one or more rolling rings 2a, 2b are made of tungsten carbide.

The rolling rings 2a, 2b can alternatively be made of cast iron or sintered steel or steel for tools.

Preferably, the one or more rolling rings 2a, 2b have a coefficient of thermal expansion comprised in the range from $0.4 \times 10^{-5} \text{ K}^{-1}$ to $0.8 \times 10^{-5} \text{ K}^{-1}$. In other words, the one or more rolling rings 2a, 2b are made of a material having a coefficient of thermal expansion comprised in the range from $0.4 \times 10^{-5} \text{ K}^{-1}$ to $0.8 \times 10^{-5} \text{ K}^{-1}$. The rolling rings 2a, 2b having a coefficient of thermal expansion in said range are particularly highly performing for this application.

The aforesaid surface 11 of the shaft 1 is preferably cylindrical or substantially cylindrical, or it may be conical.

The part of the shaft 1 to which the one or more rolling rings 2a, 2b are glued is preferably the part known as the cylindrical part.

The internal surface 21a, 21b of each rolling ring 2a, 2b may be cylindrical, or substantially cylindrical, or may be conical.

Each internal surface 21, 21b is in particular the surface delimiting the through hole of the respective rolling ring 2a, 2b.

The adhesion of the glue 3a, 3b between the shaft 1 and each rolling ring 2a, 2b is advantageously promoted by the presence of geometric interference between them, in particular in case an anaerobic glue 3a, 3b is used. The geometric

interference, in particular diametrical, between the shaft 1 and each rolling ring 2a, 2b promotes the polymerization of the glue 3a, 3b in anaerobic environment.

Optionally, the shaft 1 may be provided with a shoulder 5, e.g. in the form of an annular protrusion. The shoulder 5 is for example adapted to act as a stroke end.

5 Optionally, also the flank of a rolling ring 2a can be glued to said shoulder 5, or annular protrusion.

Between the shoulder 5 and a rolling ring 2a there may be provided a spacer element 4a, in particular having annular shape. The spacer element 4a may also optionally be glued to the shaft 1, in particular to the surface 11 of the shaft 1; and/or
10 the spacer 4a may optionally be glued to the protrusion 5 and/or to the rolling ring 2a, in particular to the flank of the protrusion 5 and/or to the flank of the rolling ring 2a.

In the case wherein the roll 1 is provided with a plurality of rolling rings 2a, 2b, they may optionally be glued together, in particular by gluing on the flanks of the
15 rolling rings 2a, 2b. In particular, a rolling ring is glued, in particular directly glued, to one or two rings adjacent thereto.

In the case wherein a plurality of rolling rings 2a, 2b are provided, between them there may also be provided at least one spacer element 4b, preferably having annular shape. The spacer 4b (or spacers) between the rolling rings 2a, 2b may also
20 optionally be glued to the shaft 1, in particular to the surface 11 of the shaft 1; and/or the flank of each rolling ring 2a, 2b may optionally be glued to a spacer 4b. In other words, the rolling roll may comprise a spacer element 4b between the mutually consecutive rolling rings 2a, 2b; and optionally the mutually consecutive rolling rings 2a, 2b are glued to a same spacer element 4b.

25 In the non-limiting example illustrated, two rolling rings 2a, 2b are provided, between which there is a spacer 4b. The shaft 1 is provided with a shoulder 5, and between the rolling ring 2a and said shoulder 5 there is provided a spacer 4a.

Solely by way of example, due to the diametrical interference between the rolling rings 2a, 2b and the shaft 1, the mounting of each rolling ring 2a, 2b on the shaft 1
30 can take place by heating the rolling ring 2a, 2b in order to dilate it, particularly in order to temporarily cancel out the diametrical interference between the rolling ring 2a, 2b and the shaft 1, regardless of the material of which the components are made.

The heating time range of the rolling ring 2a, 2b may be for example from 50 to about 200 °C. Preferably, each rolling ring 2a, 2b is heated to about 100°C.

The invention also relates to a method for dismounting the one or more rolling rings 2a, 2b from the shaft 1 of a rolling roll 10 on which they are mounted, wherein
5 the following steps are provided:

a) cooling the shaft 1 by means of a cryogenic fluid, preferably liquid nitrogen, in particular so as to reduce the diameter of the shaft 1, in particular with respect to the diameter of the shaft 1 itself at room temperature, or in other words with respect to the original diameter of the shaft 1 at room temperature;

10 b) removing the one or more rolling rings 2a, 2b from the shaft 1 and the optional one or more spacers 4a, 4b. In step b), in particular, the one or more rolling rings 2a, 2b and the optional one or more spacers 4a, 4b are slid with respect to the shaft 1, until the respective hole no longer surrounds the shaft 1, i.e. until the shaft 1 and the one or more rolling rings 2a, 2b (and the optional one or more spacers 4a, 4b)
15 are dismounted.

In general, the method allows the shaft 1 and the one or more rolling rings 2a, 2b and the optional spacers 4a, 4b to be dismounted and separated from one another. The reduction of the diameter of the shaft 1 caused by the cooling in step a) breaks the layer of glue between the shaft 1 and the one or more rolling rings 2a, 2b, which
20 can thus be removed.

Preferably, in step a) the shaft 1 is cooled by immersion in the cryogenic fluid, in particular in the cryogenic liquid.

All or substantially all of the shaft 1 can be immersed, or only a part of the shaft 1 can be immersed, e.g. half or a third of its length, in particular so as to try to cool the
25 shaft 1 only.

Optionally, in step a) the shaft 1 and the one or more rolling rings 2a, 2b and any optional spacers 4a, 4b are immersed, together, in said cryogenic fluid.

The cryogenic fluid is, in particular, a cryogenic liquid. "Cryogenic liquid" means in particular a fluid having a boiling point less than - 100 °C (minus 100 °C) at
30 atmospheric pressure, e.g. liquid nitrogen at atmospheric pressure.

The method is particular adapted to be performed when the one or more rolling rings 2a, 2b are made of carbide, in particular metallic carbide, e.g. tungsten carbide, and the shaft 1 is made of steel, for example.

Advantageously, the different coefficient of thermal expansion of the one or more
5 rolling rings 2a, 2b, preferably made of carbide, and of the shaft 1, preferably made
of steel, is exploited. For example, by immersing the glued assembly of the shaft 1
and the rolling ring(s) 2a, 2b, or even only the body of the shaft 1, in a cryogenic
fluid (e.g. liquid nitrogen) the higher coefficient of expansion (in this case reduction)
of the steel shaft 1 is exploited so as to reduce its diameter, thus detaching the one
10 or more rolling rings 2a, 2b and the optional one or more spacers 4a from the shaft
1, and thus making the shaft 1 removable or in other words allowing the one or more
rolling rings 2a, 2b and the one or more spacers 4a, 4b to be removed.

The invention also relates to a rolling apparatus or system comprising a plurality
of rolling rolls 10.

15

CLAIMS

1. A rolling roll (10), in particular for long products, comprising a shaft (1) and one or more rolling rings (2a, 2b) mounted on the shaft (1),
wherein the shaft (1) is coupled with interference to the one or more rolling rings
5 (2a, 2b), in particular without mechanical clearances between the shaft (1) and the one or more rolling rings (2a, 2b);
and wherein the internal surface (21a, 21b) of the one or more rolling rings (2a, 2b) is glued to a surface (11) of the shaft (1).
2. A rolling roll (10) according to claim 1, wherein said surface (11) of the shaft (1)
10 has a larger diameter with respect to the diameter of said internal surface (21a, 21b) of the one or more rolling rings (2a, 2b).
3. A rolling roll (10) according to claim 1 or 2, wherein the shaft (1) has a greater coefficient of thermal expansion with respect to the coefficient of thermal expansion of the one or more rolling rings (2a, 2b).
- 15 4. A rolling roll (10) according to any one of the preceding claims, wherein the shaft (1) is made of steel and the one or more rolling rings (2a, 2b) are made of carbide, preferably metallic carbide.
5. A rolling roll (10) according to any one of the preceding claims, wherein the one or more rolling rings (2a, 2b) are made of tungsten carbide.
- 20 6. A rolling roll (10) according to any one of the preceding claims, wherein the one or more rolling rings (2a, 2b) have a coefficient of thermal expansion comprised in the range from $0.4 \times 10^{-5} \text{ K}^{-1}$ to $0.8 \times 10^{-5} \text{ K}^{-1}$.
7. A rolling roll (10) according to any one of the preceding claims, wherein said surface of the shaft (11) is cylindrical.
- 25 8. A rolling roll (10) according to any one of the preceding claims, wherein the one or more rolling rings (2a, 2b) are glued directly to said surface of the shaft (11), in particular without any bodies interposed between the shaft (1) and the one or more rolling rings (2a, 2b).
9. A rolling roll (10) according to any one of the preceding claims, wherein the
30 internal surface (21a, 21b) of the one or more rolling rings (2a, 2b) is glued to said surface (11) of the shaft (1) by means of an anaerobic glue.

10. A rolling roll (10) according to any one of the preceding claims, wherein the shaft (1) is provided with a shoulder (5), or annular protrusion; and wherein the flank of a rolling ring (2) is glued to said shoulder (5).

11. A rolling roll (10) according to any one of the preceding claims, comprising a plurality of said rolling rings (2a, 2b).

12. A rolling roll according to claim 11, wherein said rolling rings are glued to one another.

13. A rolling roll according to claim 11, comprising a spacer element (4b) between mutually consecutive rolling rings (2a, 2b); and wherein each spacer element (4a) is glued to the shaft (1); optionally wherein the mutually consecutive rolling rings (2a, 2b) are glued to a same spacer element (4b).

14. A method for dismounting the one or more rolling rings (2a, 2b) from the shaft (1) of a rolling roll (10) according to any one of the preceding claims, wherein the following steps are provided:

a) cooling the shaft (1) by a cryogenic fluid, preferably liquid nitrogen, in particular so as to reduce the diameter of the shaft (1), in particular so as to break the layer of glue between the shaft (1) and the one or more rolling rings (2a, 2b);
b) removing the one or more rolling rings from the shaft (2a, 2b).

15. A method according to claim 14, wherein in step a) the shaft (1) is cooled by immersion in the cryogenic fluid.

16. A method according to claim 14 or 15, wherein in step a) the shaft (1) and the one or more rolling rings (2a, 2b) are immersed in said cryogenic fluid.

17. A rolling apparatus comprising a plurality of rolling rolls (10) according to any one of claims 1 to 13.

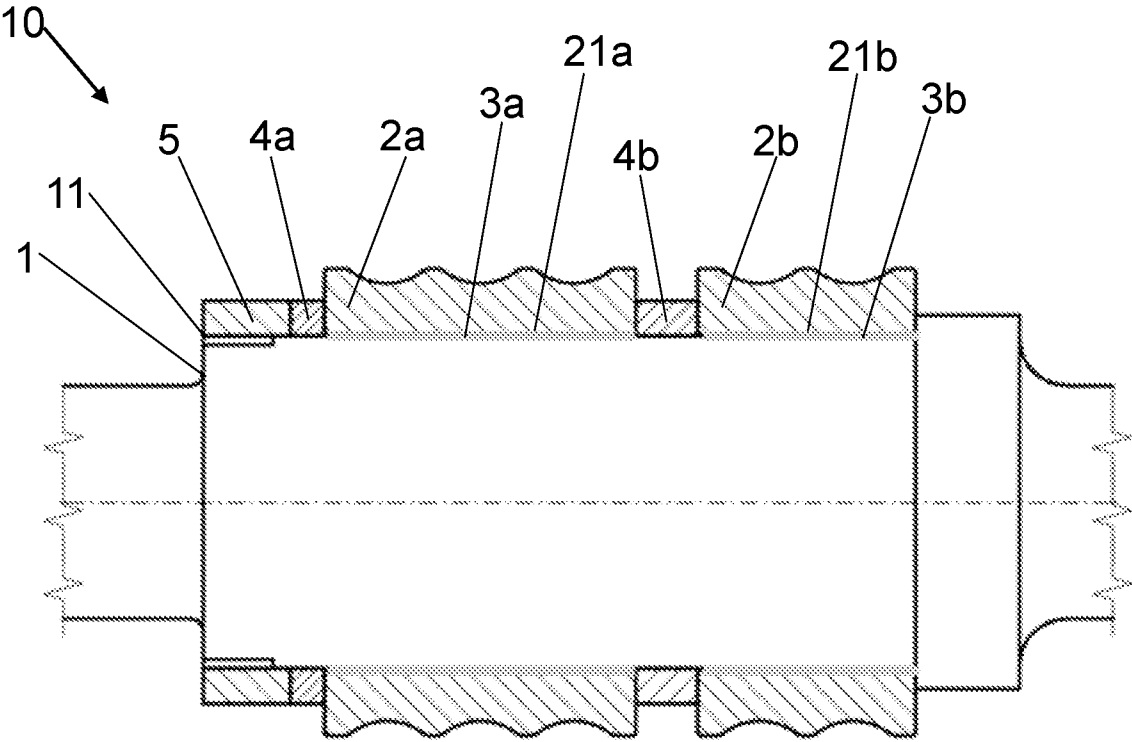


Fig. 1

INTERNATIONAL SEARCH REPORT

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A. CLASSIFICATION OF SUBJECT MATTER INV. B21B27/03 ADD. According to International Patent Classification (IPC) or to both national classification and IPC		
B. FIELDS SEARCHED Minimum documentation searched (classification system followed by classification symbols) B21B B23P Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched Electronic data base consulted during the international search (name of data base and, where practicable, search terms used) EPO-Internal		
C. DOCUMENTS CONSIDERED TO BE RELEVANT		
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☒ Further documents are listed in the continuation of Box C. ☒ See patent family annex.		
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Name and mailing address of the ISA/ European Patent Office, P.B. 5818 Patentlaan 2 NL - 2280 HV Rijswijk Tel. (+31-70) 340-2040, Fax: (+31-70) 340-3016		Authorized officer Forciniti, Marco

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